

# Using Digital Design Data in Construction Panel Discussion

*IHEEP 2011*

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*Track 7B*

*8:30 – 10:00 AM*

*Wednesday, Sept 14, 2011*

Danny Kahler, PE

Kahler Engineering Group

Richardson, Texas



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# Speaker Background

## Danny Kahler, PE

25 Years of Experience in Transportation Design and Construction

Licensed in Texas, Arkansas, Florida, and Utah

Independent Design Quality Assurance for State Highway 130 in Austin TX, a \$1.3B Design-Build Tollroad

Risk Engineering Program for the Intercounty Connector in Rockville, MD, a \$2.4 B Design-Build Tollroad

Quality Management Program for the KCICON in Kansas City, a \$250M Design-Build Signature Bridge

ASQ Chair for Development of a Body of Knowledge in Design Quality Management



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# What Do I Mean By “Model-Centric”?

## Basic Vocabulary

**Model** - A simplified representation of a system at some particular point in time or space intended to promote understanding of the real system

**System** – A system exists and operates in time and space

(Definitions obtained from Society for Modeling and Simulation International)



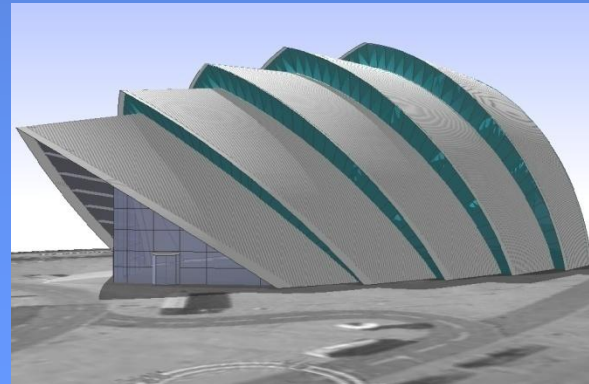
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# Does “Model” Mean 3D?

A model is anything that represents the system. A system can be 1D, 2D, 2D+time, 3D, stress, flow, finite element, finite boundary, etc.

**Most transportation design information is in 2D.** The 3D project is constructed by adding vertical elements such as profiles, superelevations, and templates

Nice, clean 2D files communicate roughly 2/3rds of the relevant design information



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# Model Centric Design

- **Model Centric Design** – All significant design processes extract information from and update changes to a digital model that represents the real system



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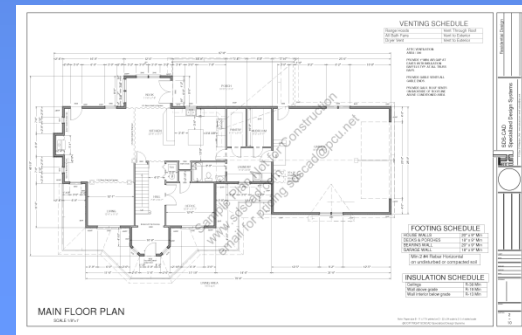
# Traditional Design Technology

The “model” is represented by ***analog*** lines and numbers on rectangular sheets

- Each sheet only shows small section of the design
- Visualizing the proposed design requires significant practical experience
- Changes to the design are difficult
- Large labor forces are required for drafting
- Requires extensive training to interpret during construction



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# Enabling Technology

Computer software with design in the same ***digital*** coordinate system that will be used for construction

Computer networks allowing multiple users to see the latest version of any design component in it's actual location

Positioning technology and automated machine guidance that allow us to construct the project exactly the same way that it's designed in the computer



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# *BUT,* IT'S NOT ABOUT SOFTWARE!

Software packages are just tools that help us work  
with the data

We use software to retrieve the data, analyze it,  
manipulate it, put it back in, and present it

Model-centric design is about improving the way  
we use the data to make design decisions





# *Software By Itself Won't Improve Anything*

Design firms continue to invest in the latest ***digital*** software with little improvement in real productivity

Managers eventually turn deaf ears to production staff requests for each new “killer” application

“Old School” engineers still cling to the old ***analog*** ways making the hybrid process even more inefficient than the old ink and mylar system



# We Need Model-Centric Thinking

Firms can separate **pure design** from  
**construction document drafting**

Managers can make choices about hardware and  
software investments based on  
**actual productivity needs**

Senior designers can base their decisions on the  
actual design, not limited sheet views of it



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# What do Design Firms Need?

People trained to communicate in the “language” of design models and real-time design changes

Development of guidelines to transition from ***analog*** thinking to ***digital*** thinking

Establishment of new skills in how to control and assure the quality of the model

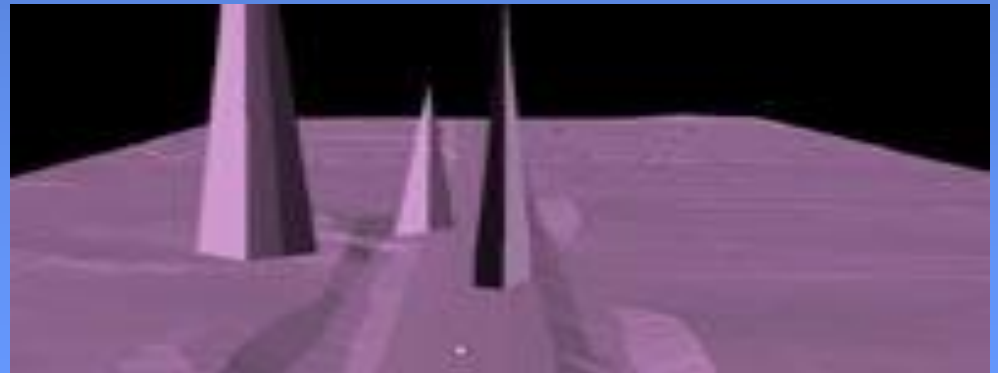
We need Model-Centric Quality Assurance™



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# Model-Centric Quality Assurance™

Model-Centric Quality Assurance occurs when the evaluation of adequacy of a design is based on the integrated review of the actual ***digital*** design model rather than a fragmented inspection of individual ***analog*** views (plans)



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# Traditional Design QA

- Document Based (Analog)
- Multiple Iterations of Construction Plans
- Heavy Focus on Appearance



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# Is This What We Want?

- Frustrating Amount of “Drafting” Comments
- Reviewer Reward based on Volume of Comments Generated
- Have fonts and line weights ever caused a single construction claim?



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# Are We Really Happy With The Current Approach?



## Are we ready for a change?



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# Implementing Model-Centric QA™

Requires standards for model definition - may already be hidden in agency CADD standards

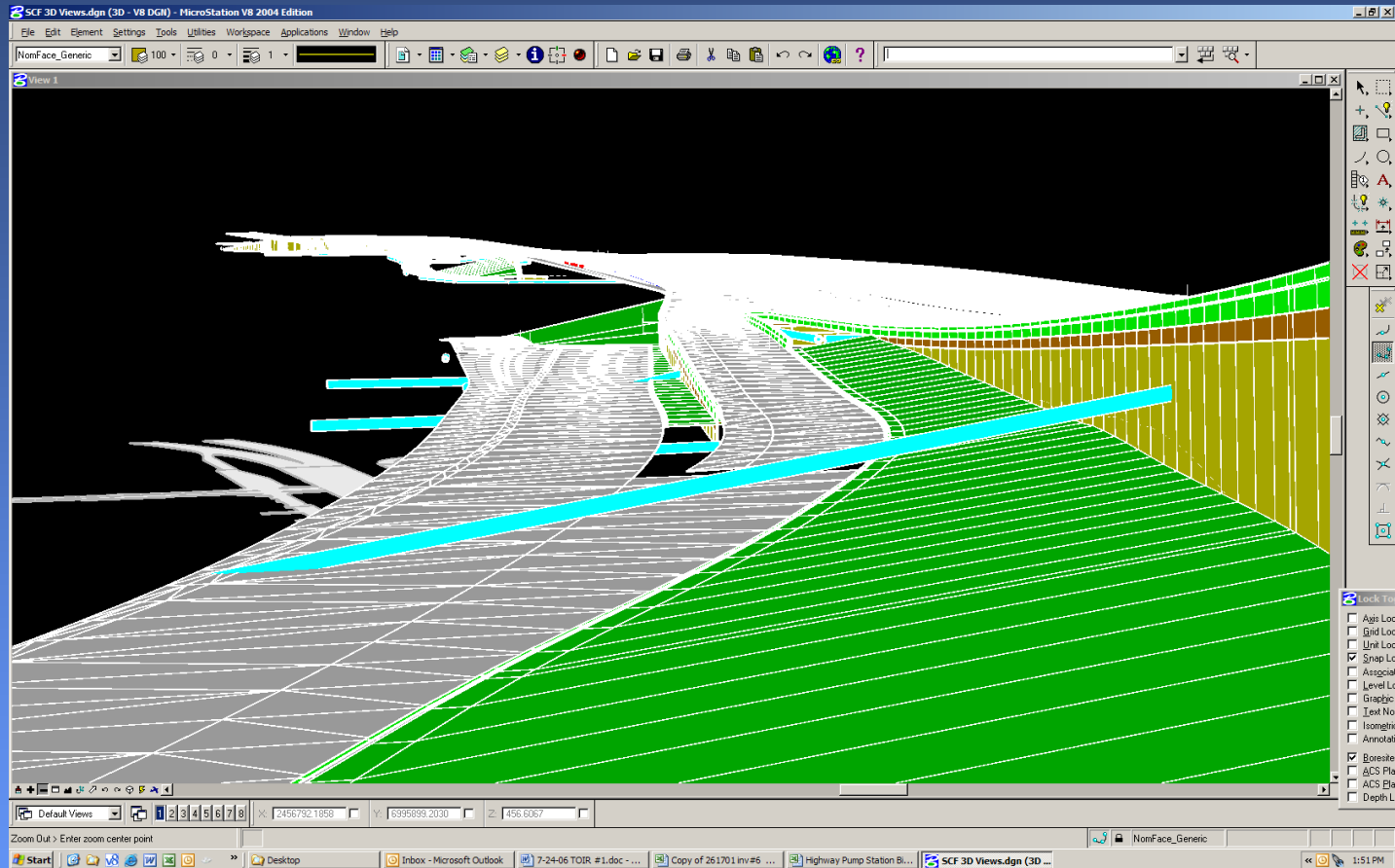
Needs standardized or compatible software that communicates the proposed design to the reviewer

Standardized electronic information must consider the needs of modern contractors using electronic models to build their projects





# Real World Example



Problems with storm sewer profiles found early in the design process



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# Can Contractors Take Advantage of a Design Model?

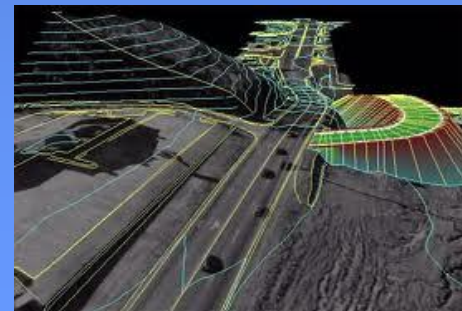
Some contractors already request source design files

Many report the ***digital*** files have fewer errors than the signed and sealed ***analog*** paper plan sheets

Agencies can establish design contract requirements for designer-validated models adequate for bidding purposes



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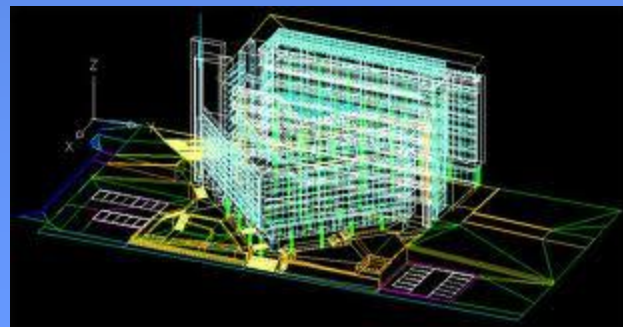
# Design Model Quality

2D Files – filter on different types of construction, lines exact not schematic

3D Files – smooth transitions,

Geometry Files – index of alignment names, translatable

All Files – all trash, scratch, draft, trial, temp, and personal elements removed



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# Minimum Standards

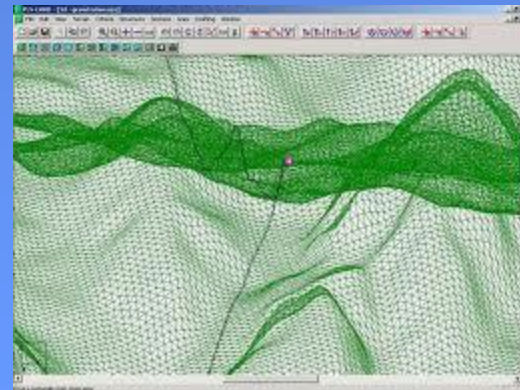
3D surface model is nice, but not always available

Pay items should be on individual layers so contractor can sort them out

Elements in the file should be the same as the reference point in the field

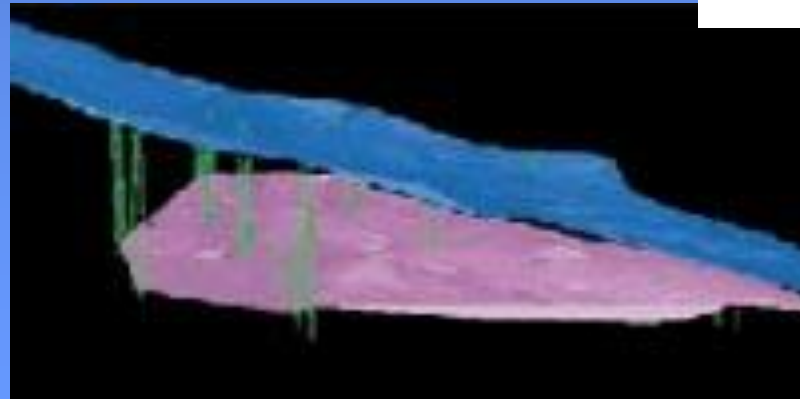


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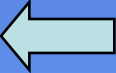
# Model-Centric Construction QA

- Layout and inspection directly from files
- Collection of GPS coordinates with quality data
- Management of quality in GIS
- “GeoPDF”



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# Evolution of Model-Centric

- Plans Only
- Plans Visualization
  - Plans  Model
- Roundtrip Engineering
  - Plans  Model
- Model-Centric
  - Plans  Model
- Model Only
- “What’s a model?”
- The plans build the model
- Plans and model coexist
- The model builds the plans
- Pure design (no more plan sheets)



# Taxonomy of Model-Centric QA

- Fit
  - The static 3-D Integration of the Project
- Flow
  - Things the project must transport: storm drainage, sewage, vehicles, etc.
- Function
  - Ability of subsystems to do their jobs: signals, gates, message boards, roadway signs, etc.



# Main Source of Problems

- BAD FIT – lines in design model don't reflect the constraints of the real world
  - Inlets not matching pavement
  - Retaining walls not matching bridges
  - Structural conflicts
  - Construction sequencing doesn't allow enough room for traffic control

